From RE Integration to RE Domination

Presentation for IEA

Easy Smart Grid GmbH
28.05.2018
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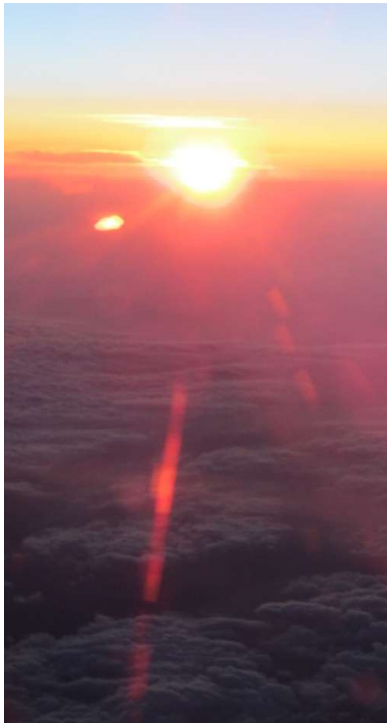


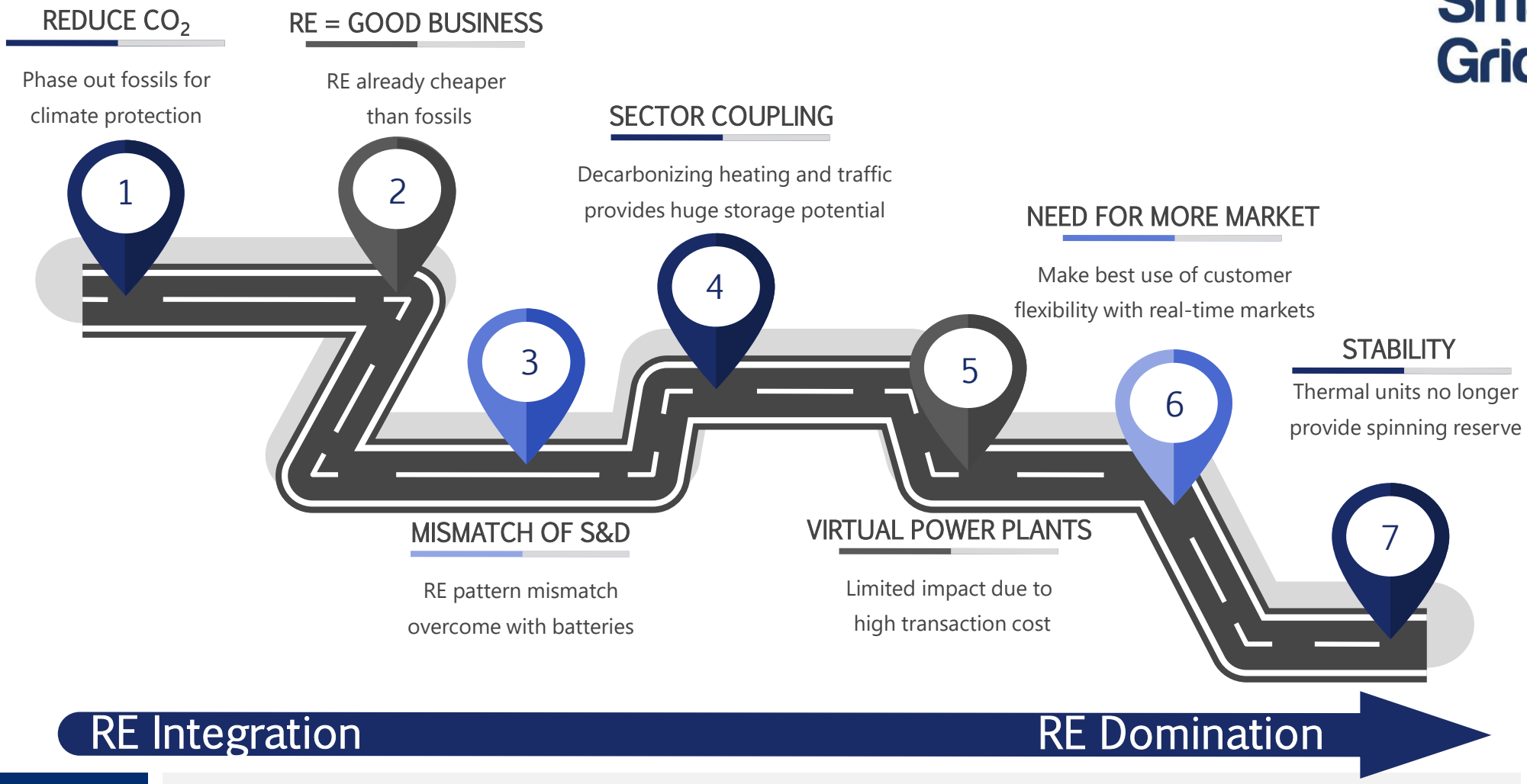
Our talk will focus on three subjects:

1. **How can total cost of storage be reduced**
   by utilizing and stimulating a maximum of flexibility (generation, consumption, dedicated storage) in an economically attractive and efficient way?

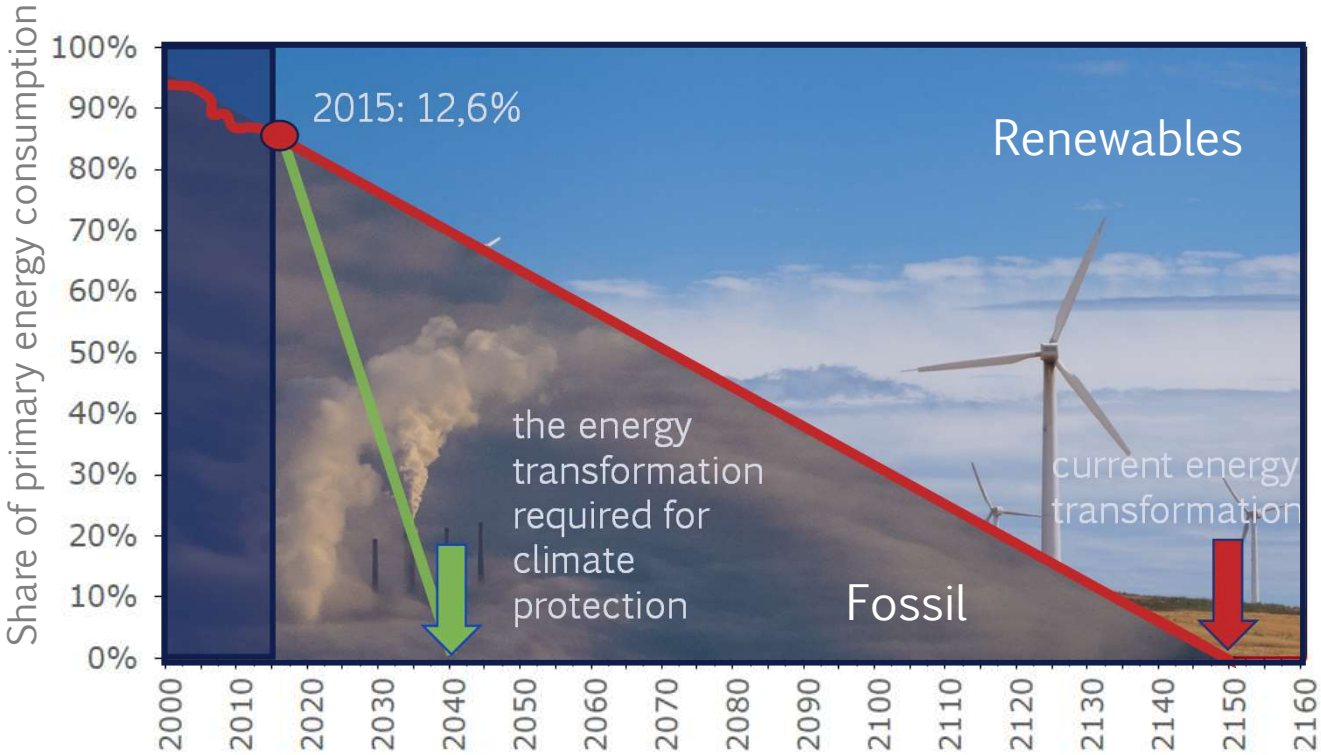
2. **How can smart markets be implemented**
   combining the desired benefits (resiliency, stability, data and cyber protection, simplicity) with low cost (CAPEX and OPEX)?

3. **How can IEA members harvest the conversion potential available today**,
   and how can this open up more options to sustainable energy systems world-wide?

Roadmap Energy Transition

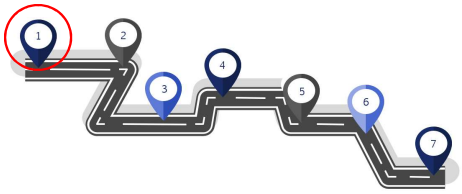


Step 1. Reduce CO_2
Ambition and Reality in Germany



Install more RE – and faster !

Source:
Prof. Volker Quaschning, HTW Berlin



Step 2. RE = Good Business
Renewables already cost competitive

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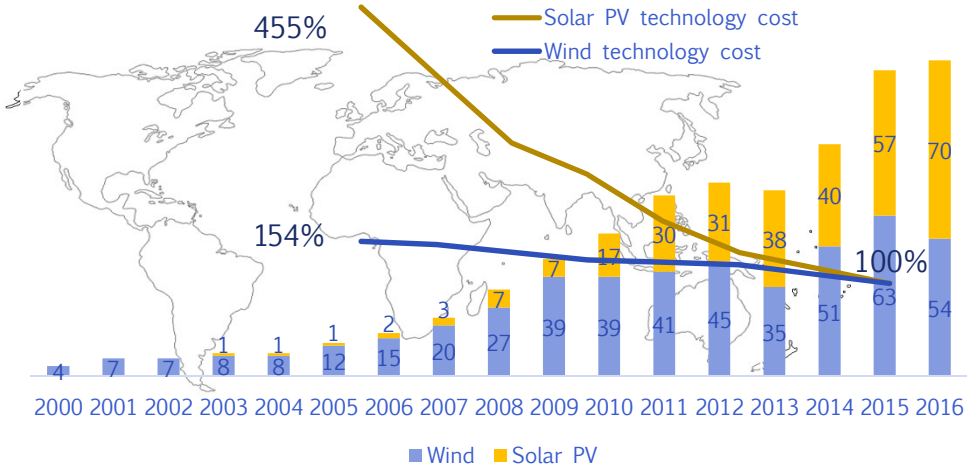
Global annual new capacity in GW/yr

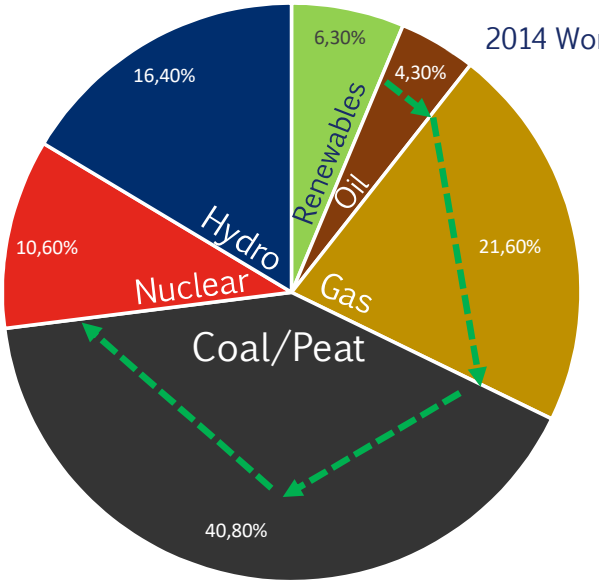


Subsidies → Cost competitive

World Wind energy association – statistics
IRENA Renewable capacity highlights 2017

- Cost reduction of RE by economies of scale (PV, Wind)
- Current growth already driven by Economics

2014 World electric generation (IEA,2016)

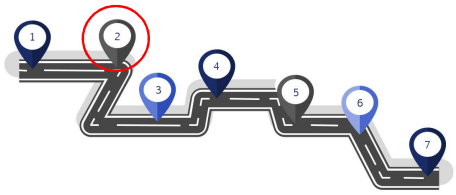


Source (LCOE $/MWh)	Low	High
PV Utility Scale	43	53
Wind	30	60
Diesel	197	281
Natural Gas Reciprocating Engine	68	106
Gas Combined Cycle	42	78
Coal	60	143
Nuclear	112	183

Lazard (2017)

- RE cheaper than 5% of primary generation (Diesel/HFO)

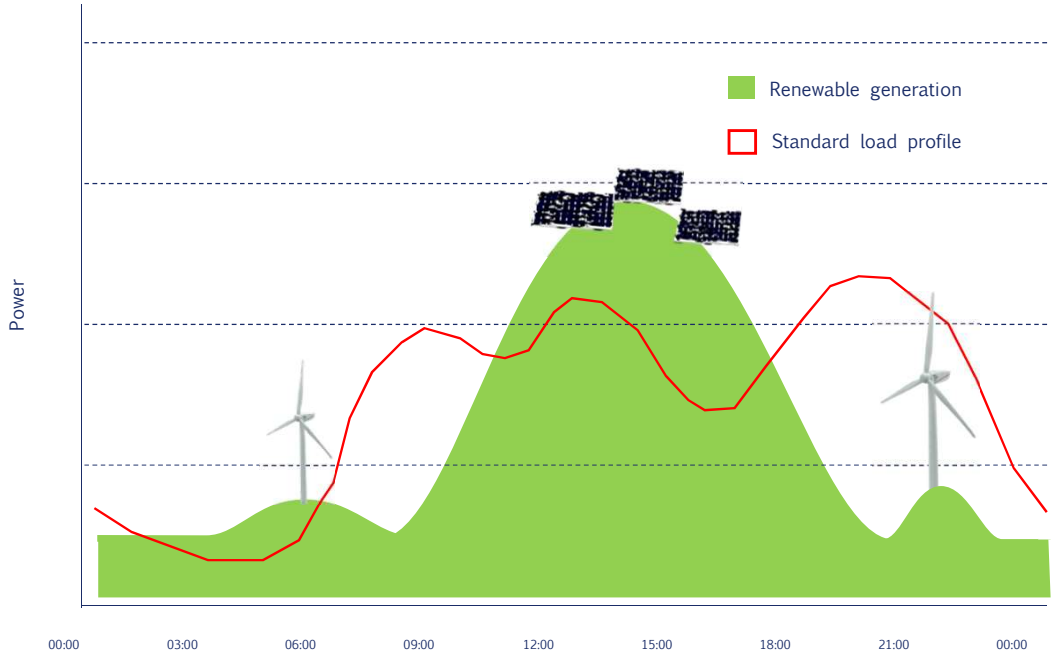
Cost efficiency !



Step 3. Mismatch of S&D (Supply and Demand)
Old paradigm no longer useful (manage generation side)

Need: Storage at lower CAPEX!

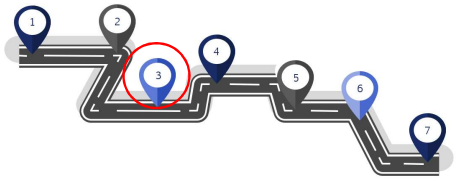
Renewable energy pattern



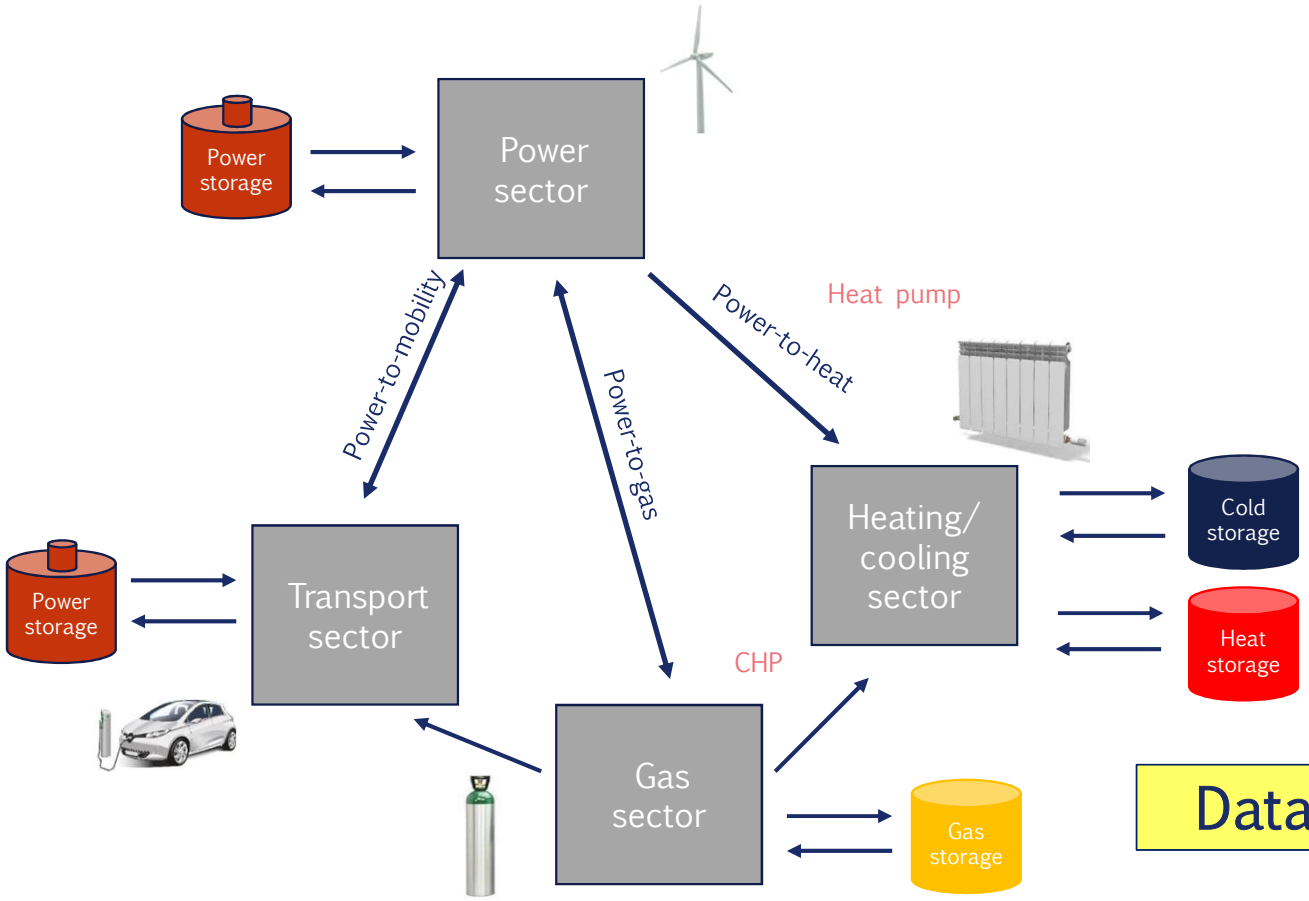
- Energy generation from sun and wind depends on weather
- At certain RE level fossils can no longer compensate their pattern
- Electricity storage is the traditional answer (adapt RE supply to demand)

?

- But: Batteries kill RE economics !



Step 4. Sector coupling
Add huge storage capacity - cheaply

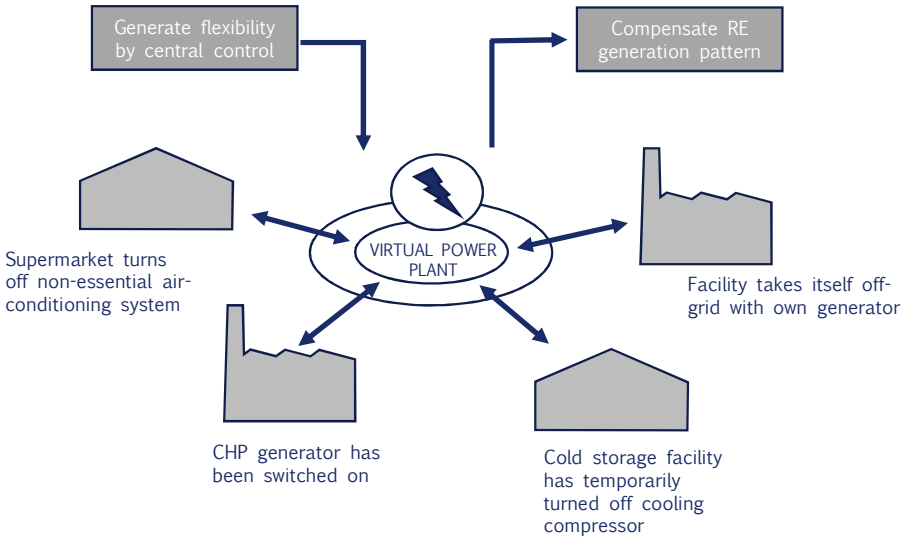


- Decarbonize heating, cooling and mobility to reduce CO_2
- They bring cheap energy storage to → low cost “virtual batteries”
- Co-generation (CHP) can fill the gaps RE generation leaves
- System coordinated with “smart” technology

Ease of operation !

Data protection !

Step 5. Virtual Power Plants
Still old paradigm ▶ High transaction cost



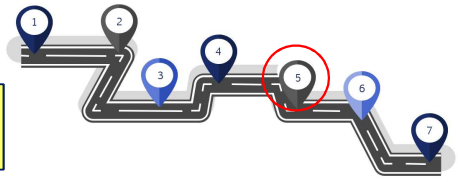
Four Entry Barriers to Flexibility Market

- Product Fragmentation & Fit
- Minimum Required Quantity
- Availability over Period
- Pre-Qualification ★

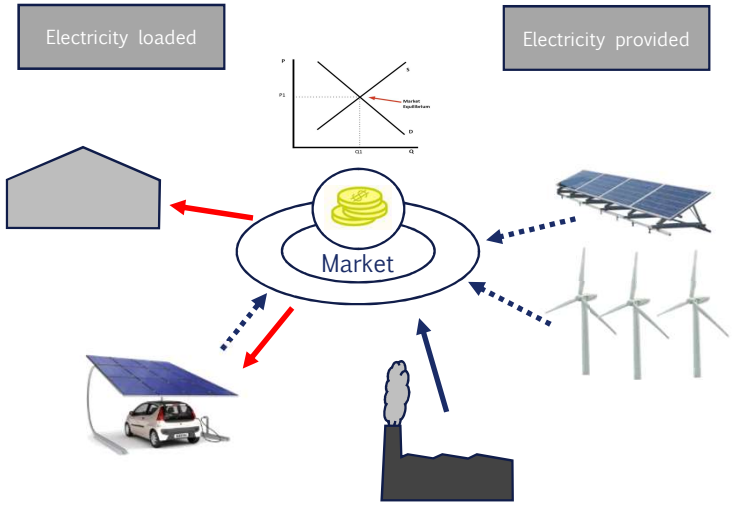
Flexibility of household devices, heat pumps, micro CHPs, electric cars can be used if transaction cost become much lower

Scalability by lower transaction cost !

★ **ICT: CAPEX/OPEX**



Step 6. Need for more market
More participants, faster response



Data protection !

- Day Ahead Trade
- Intra Day (Spot) Trade
- Tertiary Control Power
- Secondary Control Power
- Primary Control Power
- Spinning reserve

Real Time Market?

"Real" Real Time Market

- Customers retain control
- No confidentiality issues
- Fair financial reward

= High liquidity

Reward flexibility!

Real-Time Market / easy access !

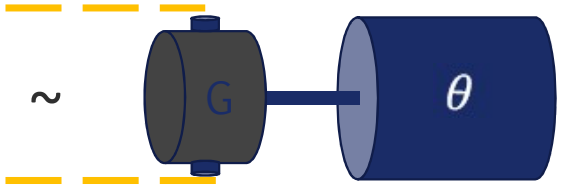
Step 7. Stability without fossils

Goal: secure systems operation without thermal units

Resilience !

RE Integration

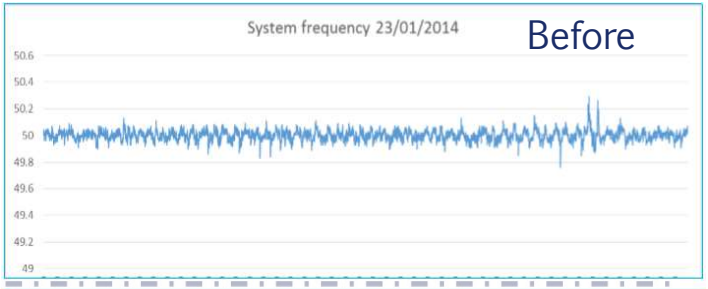
RE Domination



Synchro generators provide spinning reserve today

1

El Hierro system frequency



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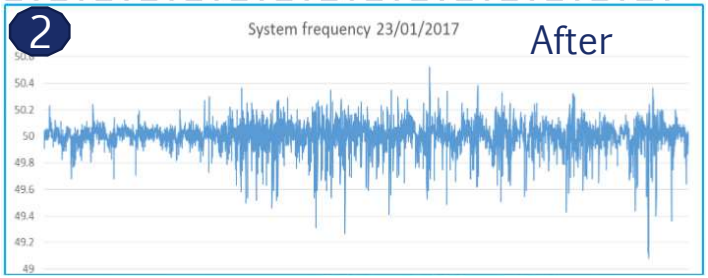
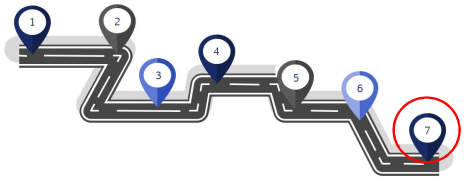


"Virtual" Synchro Generator

3

With more RE, fewer (no) synchro generators can provide spinning reserve



Necessary system features for RE domination

Efficiency: Higher performance at lower cost

High resilience: No negative impact if some subsystems fail

High stability: Absence of latency through real-time system response

Low investment: In storage, communication and information processing infrastructure (CAPEX ► OPEX)

Flexible system: Empower customers, treat them fairly by rewarding them for the value they create

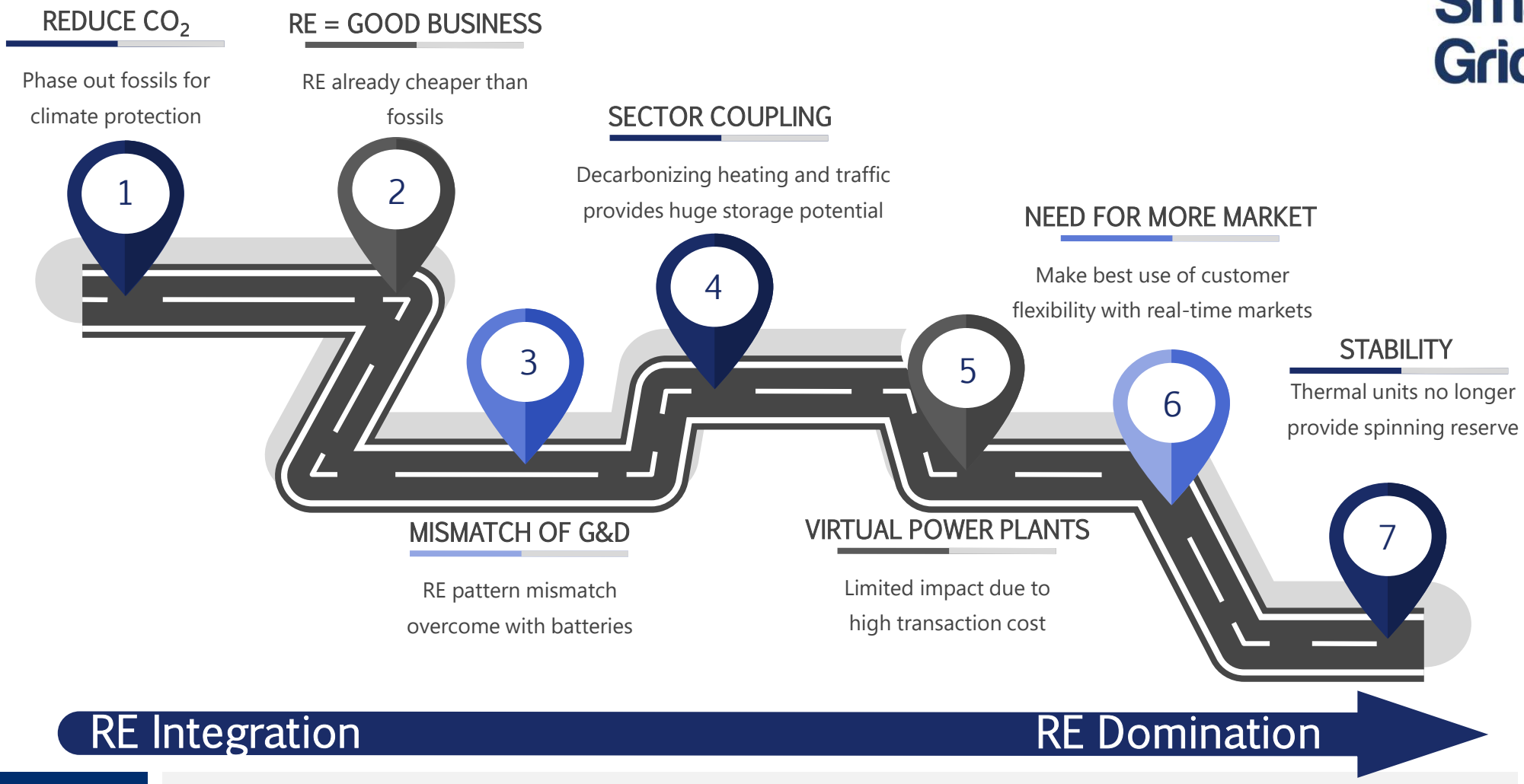
Ease to migrate and scale: Integrate seamlessly into legacy system and drive energy cost down with RE/flexibility

Ease of operation: Ensure ease of maintenance and efficient emergency control by low complexity (OPEX)

Cyber protection: Make it impossible for intruders to manipulate information base and exchange

Private data protection: No need to disclose any private data

ICT supports the Roadmap?



Necessary system features
Easy Smart Grid provides all of them

Easy Smart Grid GmbH

Efficiency: Higher performance at lower cost ✓

High resilience: No negative impact if some subsystems fail ✓

High stability: Absence of latency through real-time system response ✓

Low investment: In storage, communication and information processing infrastructure (CAPEX ► OPEX) ✓

Flexible system: Empower customers, treat them fairly by rewarding them for the value they create ✓

Ease to migrate and scale: Integrate seamlessly into legacy system and drive energy cost down with RE/flexibility ✓

Ease of operation: Ensure ease of maintenance and efficient emergency control by low complexity (OPEX) ✓

Cyber protection: Make it impossible for intruders to manipulate information base and exchange ✓

Private data protection: No need to disclose any private data ✓

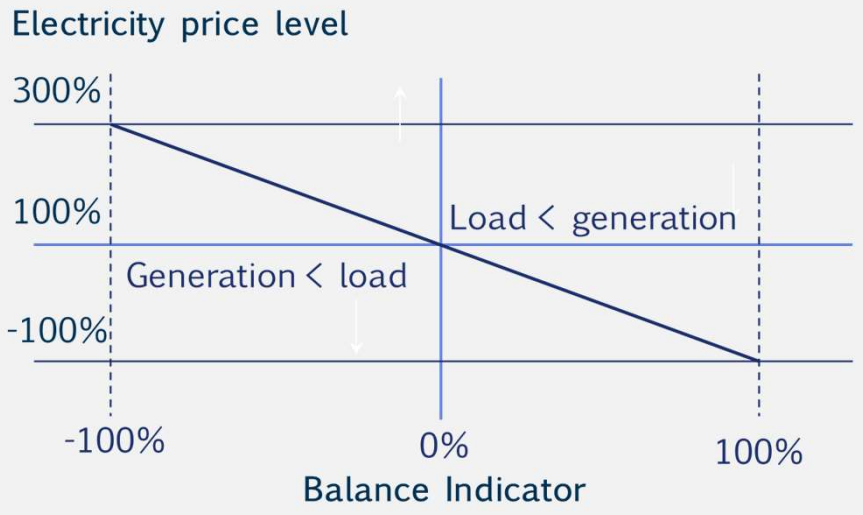
Easy Smart Grid Approach

Innovative technology to support the grid by creating a market environment based on grid state variables.

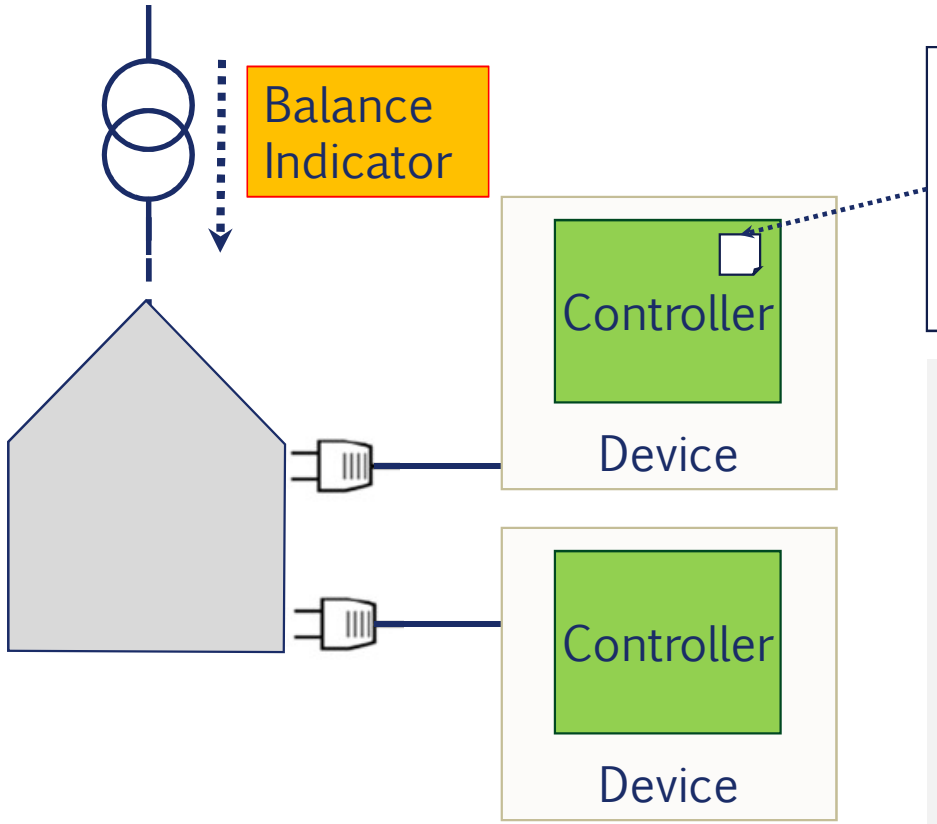
- System reacts immediately (real-time)
- Energy infrastructure provides communication platform
- High resilience, easy to maintain

Balance indicator shows generation/load mismatch and builds bridge for physics to market

- Use Customer flexibility
- **Dynamic prices** incentivize customers to cooperate.
- Customer flexibility supports grid with “virtual batteries“.



Smart controller



Algorithms are integrated into control hardware

- Interpret Balance indicator

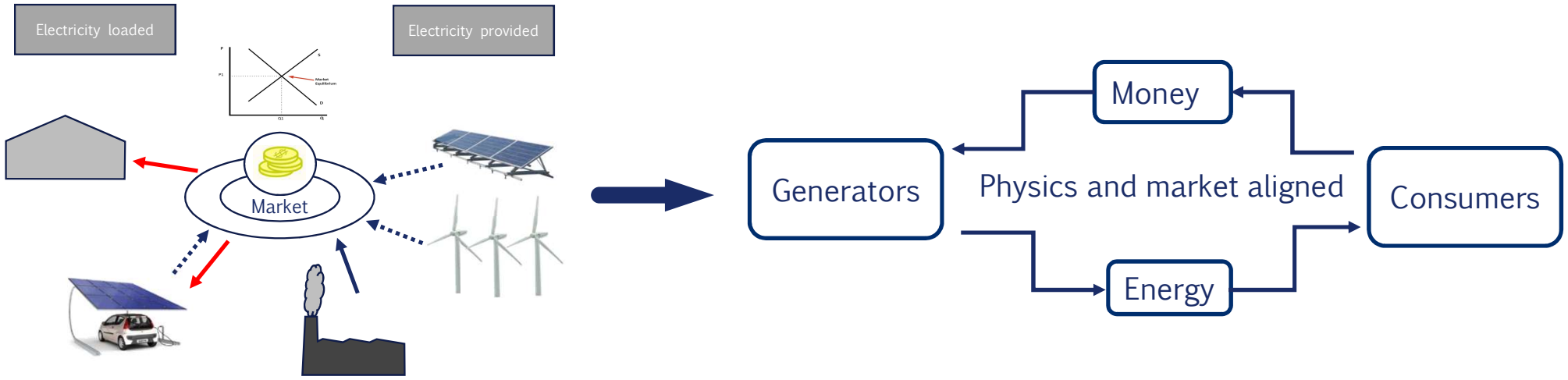
✚

- Local conditions (minimum operating time, storage level, etc)

Broadly available flexibility has great savings potential by "virtual batteries".

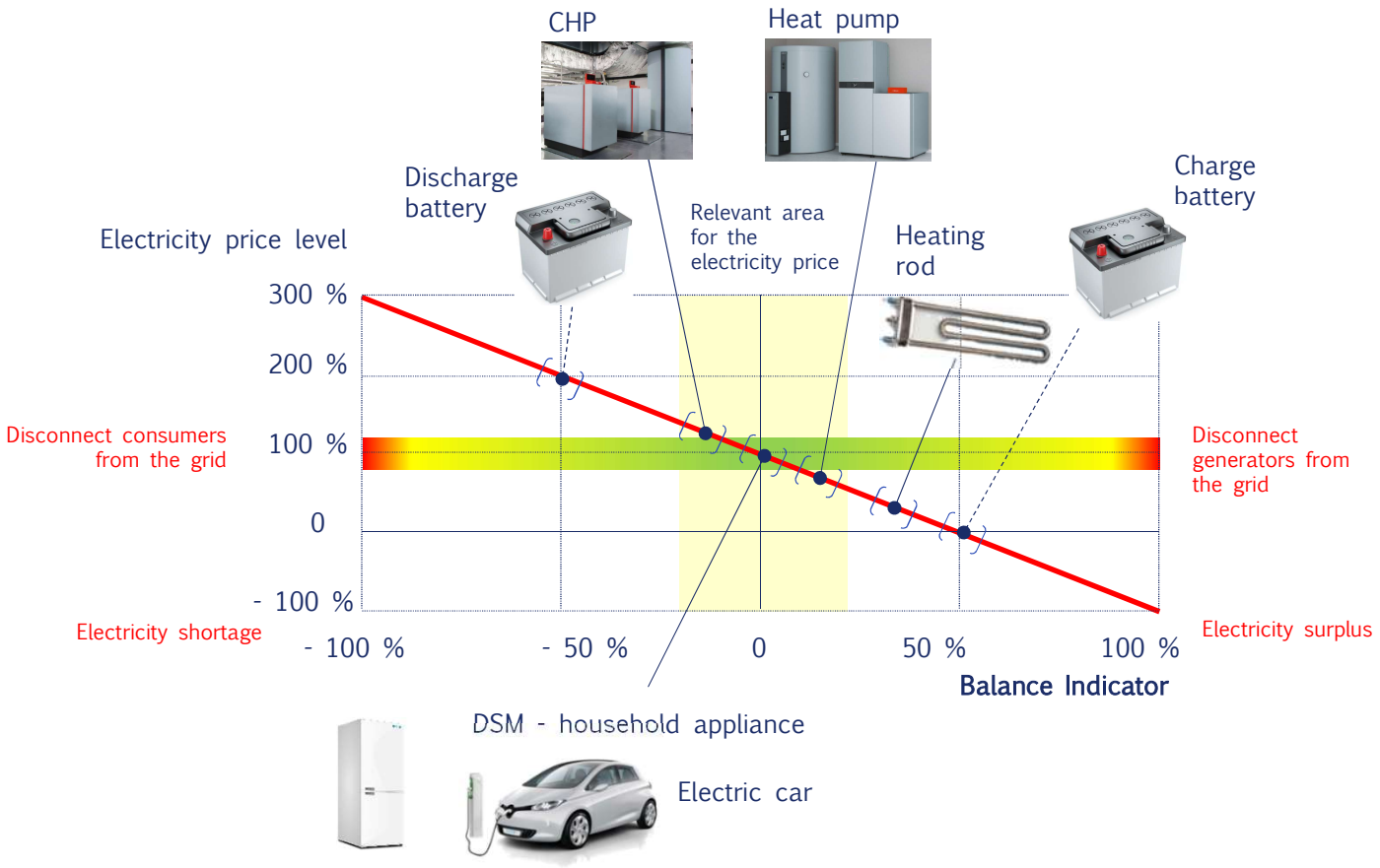
- Pumping (water desalination, processing, supply) in combination with reservoirs
- Cooling (buildings, food, ice making for fishery)
- Heating (heat pumps and CHP) in combination with thermal storage
- Electric cars (just charging, or even V2G)
- Household goods (washing, cooling, freezing)
- Industrial processes

Extension of physical network to financial market



- Manage energy system with a **real time market**. Real time means gate closure times and trading slices in the seconds range.
- **Integration** of several market segments (day ahead, intra day, control power)
- **Cost Reduction** for smartness/trading from 10-500 kW electric down to 100 Watts, (even fridges can economically be integrated).

Automatic merit order



- Each device operates in the range **most attractive** by its price preferences to provide the service at lowest cost (or highest income).
- Fair pricing is ensured
- Automated Merit Order integrates cheapest flexibility first.

How can Easy Smart Grid support

- Support in studies, demos, pilots and migration planning to transform specific grids,
- Expand electric grid to a market platform giving all customers access to variable prices,
- Supply controllers (units, modules or software code) that receive variable prices and translate them into load shifting,
- Support adaptation of grid controllers, smart meters and other equipment
- Technology licenses for equipment/appliance suppliers and grid operators.

Thank you for your interest!

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